plurality of metal layers. In an exemplary process of forming the first and second connection vias **170C1** and **170C2**, a plurality of plating processes may be performed to form the plurality of metal layers.

[0171] Thereafter, a conductive layer (not shown) may be formed on the second insulating layer **154** and the first and second connection vias **170C1** and **170C2** and patterned, thereby forming first and second conductive pads **170P1** and **170P2** that are electrically connected to the first and second connection vias **170C1** and **170C2**, respectively.

[0172] In another case, the formation of the first and second conductive pads **170P1** and **170P2** may include forming a conductive layer (not shown) on the second insulating layer **154** during the formation of the first and second conductive vias **170C1** and **170C2** and removing the conductive layer to leave only portions of the conductive layer located on the second insulating layer **154** around the first and second via holes **170H1** and **170H2**.

[0173] A top surface of the heat spreading layer **160** may be exposed by removing the second insulating layer **154** from the active pixel sensor area APS.

[0174] Referring to FIG. **22**, a passivation layer **180** may be formed on the first and second conductive pads **170P1** and **170P2**, the second insulating layer **154**, and the heat spreading layer **160**. The passivation layer **180** may be partially removed to expose top surfaces of the first and second conductive pads **170P1** and **170P2** in the first pad area PA and expose the top surface of the heat spreading layer **160** in the active pixel sensor area APS.

[0175] A color filter layer **182** and a microlens **184** may be sequentially formed on the heat spreading layer **160**.

[0176] In some embodiments, during the formation of the color filter layer **182** and the microlens **184**, the top surfaces of the first and second conductive pads **170P1** and **170P2** may be covered with a protection layer (not shown), a final passivation layer (not shown) may be formed on the color filter layer **182** and the microlens **184**, and unnecessary layers covering the first and second conductive pads **170P1** and **170P2** may be removed to expose the first and second conductive pads **170P1** and **170P2** again.

[0177] Subsequently, a support substrate **260** may be adhered to the back surface **110B** of the first substrate **110** on which the color filter layer **182** and the microlens **184** are formed. An adhesive member **262** may be interposed between the first substrate **110** and the support substrate **260** so that the support substrate **260** may be adhered to the back surface **110B** of the first substrate **110**.

[0178] A stacked structure of the first substrate **110** to which the support substrate **260** is adhered and the second substrate **210** may be turned upside down so that the back surface **210B** of the second substrate **210** may face upward.

[0179] A thinning process may be performed to remove a desired (or, alternatively, predetermined) thickness from the back surface **210B** of the second substrate **210**. For example, the thinning process may be performed by using at least one of a CMP process, a BGR process, or an RIE process.

[0180] In the image sensor **100E**, since the heat spreading layer **160** is located on the entire area of the active pixel sensor area APS, heat generated during operations of the circuits **20** (refer to FIG. **2**) included in the circuit area CA may be uniformly distributed throughout the entire area of the sensor array area SA. Accordingly, non-uniform generation of dark current may be reduced and/or prevented in the sensor array area SA.

[0181] FIG. **23** is a block diagram of a system **1000** including an image sensor according to some example embodiments.

[0182] Referring to FIG. **23**, the system **1000** may be any one of a computing system, a camera system, a camcorder, a portable phone, a scanner, a car navigation, a video phone, a security system, a game console, a medical micro-camera, a robot, or a motion detection system, which may utilize image data.

[0183] The system **1000** may include a central processing unit (CPU) (or a processor) **1100**, a non-volatile memory **1200**, an image sensor **1300**, an input/output (I/O) device **1400**, and a random access memory (RAM) **1500**. The CPU **1100** may communicate with the non-volatile memory **1200**, the image sensor **1300**, the I/O device **1400**, and the RAM **1500** via a bus **1600**. The image sensor **1300** may be embodied by at least one of the image sensors **10**, **10A**, **100**, **100A**, **100B**, **100C**, **100D**, **100E**, **100F**, **100G**, **100H**, and **1001** described above with reference to FIGS. **1** to **22** according to some example embodiments or combined with the CPU **1100** into a single semiconductor package.

[0184] FIG. **24** is a block diagram of an electronic system **2000** and interface including an image sensor according to some example embodiments.

[0185] Referring to FIG. **24**, the electronic system **2000** may be embodied by a data processing device (e.g., a mobile phone, a personal digital assistant (PDA), a portable multimedia player (PMP), or a smartphone) capable of using or supporting a mobile industry processor interface (MIPI). The electronic system **2000** may include an application processor **2010**, an image sensor **2040**, and a display **2050**.

[0186] A camera serial interface (CSI) host **2012** provided in the application processor **2010** may serial-communicate with a CSI device **2041** of the image sensor **2040** via a CSI. In this case, an optical deserializer is provided in the CSI host **2012**, and an optical serializer may be provided in the CSI device **2041**. The image sensor **2040** may include at least one of the image sensors **10**, **10A**, **100**, **100A**, **100B**, **100C**, **100D**, **100E**, **100F**, **100G**, **100H**, and **1001** described with reference to FIGS. **1** to **22**, according to some example embodiments.

[0187] A display serial interface (DSI) host **2011** provided in the application processor **2010** may serial-communicate with a DSI device **2051** of the display **2050** via a DSI. In this case, for example, an optical serializer may be provided in the DSI host **2011**, and an optical deserializer may be provided in the DSI device **2051**.

[0188] The electronic system **2000** may further include an RF chip **2060** capable of communicating with the application processor **2010**. A PHY **2013** of the electronic system **2000** may exchange data with a PHY **2061** of the RF chip **2060** based on MIPI DigRF.

[0189] The electronic system **2000** may further include a global positioning system (GPS) **2020**, a storage **2070**, a mike **2080**, a dynamic random access memory (DRAM) **2085**, and a speaker **2090**. The electronic system **2000** may perform communication operations by using a worldwide interoperability for microwave access (WiMAX) **2030**, a wireless local area network (WLAN) **2100**, and an ultra-wideband (UWB) **2110**.

[0190] It should be understood that example embodiments described herein should be considered in a descriptive sense only and not for purposes of limitation. Descriptions of features or aspects within each device or method according